

Delineation of *Schoenoplectus* sect. *Malacogeton* (Cyperaceae), New Combination, and Distinctions of Species

S. Galen SMITH^a and Eisuke HAYASAKA^b

^aDepartment of Biology, University of Wisconsin-Whitewater,
Whitewater, Wisconsin, 53190 U.S.A.;

^bBotanical Garden, Graduate School of Science, Tohoku University, Sendai, 980-0862 JAPAN

(Received on May 14, 2001)

The new combination, *Schoenoplectus* sect. *Malacogeton* (Ohwi) S. G. Smith & Hayasaka, is made and a description of the section is provided. *Schoenoplectus nipponicus*, *Sch. etuberculatus*, *Sch. torreyi* and *Sch. subterminalis* are included in sect. *Malacogeton*, and a key to these is given. We recognize the sections *Schoenoplectus*, *Actaeogeton*, *Malacogeton* and *Supini* in the genus *Schoenoplectus*, and a key to the sections and a list of North American and East Asian species included in each section are provided.

Key words: Cyperaceae, new combination, *Schoenoplectus* sect. *Malacogeton*, taxonomy

The polymorphic and polyphyletic *Scirpus* L. s. lat. in recent years has been subdivided into about 17 genera (Bruhl 1995, Goetghebeur 1998, Wilson 1981, 1989). *Scirpus* as strictly defined includes about 30 species occurring mainly in the temperate regions of the Northern Hemisphere, with *S. sylvaticus* L. as the type species (Wilson 1989). The rest of *Scirpus* s. lat. has been placed in *Actinoscirpus* (Ohwi) R. W. Haines & Lye, *Amphiscirpus* Oteng-Yeboah, *Bolboschoenus* (Asch.) Palla, *Blysmopsis* Oteng-Yeboah, *Blysmus* Schult., *Eleogiton* Link, *Ficinia* Schrad., *Isolepis* R.Br., *Oxycaryum* Nees, *Phylloscirpus* C.B. Clarke, *Pseudoschoenus* (C.B. Clarke) Oteng-Yeboah, *Schoenoplectus* (Rchb.) Palla, *Scirpoides* Ség., *Sumatroscirpus* Oteng-Yeboah, *Trichophorum* Pers., and *Websteria* S.H. Wright by recent cyperologists (Bruhl 1995, Goetghebeur and Simpson 1991, Goetghebeur 1998, Hayasaka and Ohashi

2000, Koyama et al. 2000, Smith and Yatskievych 1996, Wilson 1981). Of these segregate genera *Schoenoplectus* is comparatively large, with species distributed worldwide, the number of which is variously estimated at 50 spp. (Goetghebeur 1998), 60 spp. (Wilson 1981), 80 spp. (Hooper 1985), or over 130 spp. (Koyama et al. 2000). For North America and East Asia, 34 species are here recognized (Appendix II). Following Goetghebeur and Simpson (1991), we here define *Schoenoplectus* as excluding *Bolboschoenus* and the monotypic *Actinoscirpus*, which are sometimes included in it (Lye 1995, Strong 1994).

Schoenoplectus as currently delimited is commonly characterized by its pseudolateral inflorescences, i. e., the proximal bract usually erect and resembling the culm (Wilson 1981). Close examination shows that this is a superficial character, however, because the proximal involucre bracts of many species

now included in *Schoenoplectus* usually closely resemble the foliage leaf blades and are commonly divergent. Thus other characters are now used, especially embryo form (van der Veken 1965, Wilson 1981), stolon presence, tuber presence and form, ligule presence, culm branching, leaf position, leaf structure, spikelet arrangement, floral scale indument, and culm anatomy.

Species relationships within *Schoenoplectus* are not clear because of large morphological variation in the characters of the rhizomes, leaves, inflorescences, achenes, floral bristles and other structures that have been used to define the infrageneric taxa. To clarify the species relationships within the genus, a modern infrageneric system should be established. This was attempted by Oteng-Yeboah (1974) and Raynal (1976b), but neither of their treatments are satisfactory (Wilson 1981). In his brief paper, Oteng-Yeboah (1974) recognized and provided a key to the three subgenera *Schoenoplectus*, *Actaeogeton* and *Malacogeton*, but he neither gave descriptions for the subgenera nor the included species except for the type species. Raynal (1976a, b, 1977) recognized the four sections *Schoenoplectus*, *Actaeogeton*, *Supini*, and *Pterolepis*; with emphasis on sect. *Supini*, in which he recognized 21 species, mainly from Africa. His detailed study of *Sch.* sect. *Supini* should be extended to the rest of the species to provide a more complete classification for *Schoenoplectus*. The present paper, which emphasizes East Asian and North American species, contributes to the establishment of a modern infrageneric system for the genus. It also provides the name *Schoenoplectus* sect. *Malacogeton* and other information needed for the senior author's treatment of the genus in an upcoming volume of the Flora of North America (Flora of North America Editorial Committee 2001).

In *Schoenoplectus* three species in eastern North America and one in East Asia share

characters such as long leaf blades with unusual architecture, weak rhizomes often terminated by tubers, and often aquatic habitat and flaccid habit. Close examination shows that these four species all belong to *Scirpus* sect. *Malacogeton* Ohwi [= *Schoenoplectus* subg. *Malacogeton* (Ohwi) Oteng-Yeboah]. The required new combination is provided as follows.

Schoenoplectus (Rchb.) Palla in Verh. K. K. Zool.-Bot. Ges. Wien **38** (Sitzungsber.): 49 (1888), nom. cons.

Sect. ***Malacogeton*** (Ohwi) S.G. Smith & Hayasaka, comb. nov.

Scirpus L. subgen. *Schoenoplectus* Rchb. sect. *Malacogeton* Ohwi in Mem. Coll. Sci. Kyoto Imp. Univ. ser. B, **18**: 97 (1944).

Scirpus sect. *Bolboschoenus* Asch. ser. *Malacogeton* (Ohwi) T. Koyama in J. Fac. Sci. Univ. Tokyo, sect. 3, **7**: 288 (1958).

Schoenoplectus subgen. *Malacogeton* (Ohwi) Oteng-Yeboah in Notes Roy. Bot. Gard. Edinb. **33**: 315 (1974).

Perennials, erect or flaccid, 40–200 cm high. Rhizomes long, weak, very soft, often terminated by fleshy tubers to ca. 3 mm thick. Culms trigonous or terete, ca. 0.5–5 mm thick. Leaves basal, ca. 3 to more than 20; sheaths often free from culm and resembling blades; sheath fronts hyaline, splitting early, usually pinnate-fibrillose; blades 2 to ca. 20 per culm, some species forming emergent, erect blades and/or submerged, flaccid blades, cross-section mostly trigonous or laterally flattened, apices often blunt and eccentric; distal blade longer than sheath, ca. 0.2–10 mm wide. Inflorescences of one spikelet or capitate or 1 ×- to 3 ×- branched; proximal bract erect, structure like foliage leaf blades, ca. 1–32 cm long. Spikelets 1 to 20 per inflorescence, 5–25 × 3–6 mm. Floral scales narrowly oblong-ovate, 4–7 mm long, smooth or awn sparsely spinulose, sometimes sparsely ciliolate distally, flanks each usually with 2 to ca. 10 prominent veins (at

least in proximal part of spikelet), apices subacute, entire or minutely notched, awn (extension of midrib) ca. 0.1–0.5 mm. Perianth bristles stout, from ca. 1/2 of- to twice achene length, retrorsely to antrorsely spinulose. Anthers ca. 2–3.5 mm long. Styles 3-fid or 2-fid. Achenes yellow- to dark brown when ripe, ovoid to obovoid, prominently beaked, compressed-trigonus or biconvex, 2–4.5 mm, smooth. Flowers absent from basal sheaths. Fresh-water lakes, ponds, streams, ditches, often deeply emergent or submerged aquatic, in deep water flaccid and sometimes entirely vegetative.

Chromosome numbers reported: $2n = 42, 70, 74, 76$.

Type species: *Schoenoplectus nipponicus* (Makino) Soják.

The type species is *Sch. nipponicus*, not *Sch. etuberculatus* as stated by Oteng-Yeboah (1974), because Ohwi (1944), in his key to species of *Scirpus* subg. *Schoenoplectus*, established *Scirpus* sect. *Malacogeton*, and included only *Scirpus nipponicus*. Koyama (1958) reduced *Scirpus nipponicus* to *S. etuberculatus* subsp. *nipponicus*, and Oteng-Yeboah (1974) apparently adopted Koyama's treatment of *S. nipponicus* and gave *Sch. etuberculatus* as the type species of *Sch.* subg. *Malacogeton*.

We think the diagnostic characters of *Sch.* sect. *Malacogeton* are not sufficient to treat it as a subgenus, but still great enough to recognize it as a distinct section.

Key to species of sect. *Malacogeton*

1. Inflorescences branched, of 3 to 25 spikelets2
1. Inflorescences unbranched, of 1 to 5 spikelets3
2. Styles bifid; achenes biconvex, ca. 2 mm long; perianth bristles two times longer than achene; East Asia.....
.....*Schoenoplectus nipponicus*
2. Styles trifid; achenes trigonous, 2.5–4.5 mm long; perianth bristles about equal-

ing achene; eastern North American coastal plains

.....*Schoenoplectus etuberculatus*

3. Leaf blades ca. 1–2 mm wide; floral scales awned, the apical midrib extensions 0.2–0.5 mm; inflorescence of 1 to 4 spikelets; not forming submerged meadows; widespread in eastern North America*Schoenoplectus torreyi*

3. Leaf blades 1 mm or less wide; floral scales mucronate, the apical midrib extensions to 0.1 mm; inflorescence of one erect spikelet; forming submerged meadows of vegetative plants in deep or flowing water; widespread in North America, mostly eastern.....
.....*Schoenoplectus subterminalis*

Koyama (1958, under *Scirpus*) confused the species of *Sch.* sect. *Malacogeton* with those of *Bolboschoenus*, which is now treated as a distinct genus even when *Scirpus* is treated in a broader sense including *Schoenoplectus* (Kozhevnikov 1988). Oteng-Yeboah (1974) regarded *Sch.* sect. *Malacogeton* as intermediate between *Schoenoplectus* and *Bolboschoenus* but closer to the former in having a 'net-like ground tissue' and other characters. *Schoenoplectus* sect. *Malacogeton* is here considered to be distinguishable from the other sections as indicated in the key to the sections below (Appendix I). A close relationship between *Sch.* sect. *Malacogeton* and *Sch.* sect. *Schoenoplectus* was suggested by van der Veken (1965) based on embryo morphology.

The leaf architecture of sect. *Malacogeton* appear to be unique in *Schoenoplectus*. Both *Sch. etuberculatus* and *Sch. subterminalis* may form submerged, flaccid leaf blades and/or emergent, erect blades as described and illustrated by Schuyler (1972). In the emergent blades of *Sch. nipponicus*, *Sch. etuberculatus*, and *Sch. torreyi*, the cross-sections just distal to the ligules are thickly

V-shaped to trigonous, then in the central regions become acutely trigonous or laterally flattened with one edge channeled, then toward the apex become asymmetrically flattened-trigonous. In the wider leaf blades of *Sch. etuberculatus* and *Sch. torreyi*, the apices are blunt and markedly asymmetric, with the actual apex turned to one side.

Schoenoplectus sect. *Malacogeton* is an example of flowering plants with a disjunct distribution pattern between East Asia and North America, particularly referred to as East Asian-eastern North American distribution type, such as in *Panax*, *Symplocarpus*, *Zizania*, and *Hamamelis* (Wen 1999).

We thank the curators of Tohoku University Herbarium (TUS) and many North American Herbaria for the loan of specimens, and Mark Strong for helping the senior author prepare an early version of an infrageneric classification of *Schoenoplectus*.

References

- Bruhl J. J. 1995. Sedge genera of the world: relationships and a new classification of the Cyperaceae. *Aust. Syst. Bot.* **8**: 125–305.
- Flora of North America Editorial Committee (eds.). 2001. *Flora of North America north of Mexico*. 4+ vols., Oxford Univ. Press, New York and Oxford.
- Goetghebeur P. 1998. Cyperaceae. In: Kubitzki K. (ed.), *The families and genera of vascular plants* **4**: 141–190. Springer, Berlin.
- . and Simpson D. A. 1991. Critical notes on *Actinoscirpus*, *Bolboschoenus*, *Isolepis*, *Phylloscirpus* and *Amphiscirpus* (Cyperaceae). *Kew Bull.* **46**: 169–178.
- Hayasaka E. and Ohashi H. 2000. New combinations in Japanese *Schoenoplectus* (Cyperaceae). *J. Jpn. Bot.* **75**: 223–225.
- Hooper S. S. 1985. Cyperaceae. In: Townsend C. C. and Guest E. (eds.), *Flora of Iraq* **8**: 331–406, Ministry of Agriculture & Agrarian Reform, Republic of Iraq.
- Koyama T. 1958. Taxonomic study of the genus *Scirpus* L. *J. Fac. Sci. Univ. Tokyo, sect. 3*, **7**: 271–366.
- , Kuoh C.-S. and Leong W.-C. 2000. Cyperaceae. In: Huang T.-C. & al. (eds.), *Flora of Taiwan*, 2nd ed. **5**: 191–317. National Taiwan University, Taipei.
- Kozhevnikov A. E. 1988. Cyperaceae. In: Charkevich S. S. (ed.), *Plantae Vasculares Orientis Extremi Sovietici* **3**: 175–403. Nauka, Leningrad.
- Lye K. A. 1995. Cyperaceae. In: Thulin M. (ed.), *Flora of Somalia* **4**: 98–147. Royal Botanic Gardens, Kew.
- Oteng-Yeboah A. A. 1974. Taxonomic studies in Cyperaceae–Cyperoideae. *Notes Roy. Bot. Gard. Edinb.* **33**: 311–316.
- Raynal J. 1976a. Notes Cypérolologiques: 25. Le genre *Schoenoplectus* I. Sur quelques especes Sud-Africaines. *Adansonia*, ser. 2, **15**: 537–542.
- . 1976b. Notes Cypérolologiques: 26. Le genre *Schoenoplectus* II. L'amphicarpie et la sect. *Supini*. *Adansonia*, ser. 2, **16**: 119–155.
- . 1977. Addendum to notes Cypérolologiques 26. *Adansonia*, ser. 2, **16**: 530.
- Schuyler A. E. 1972. Morphological and anatomical differences in leaf blades of three North American aquatic bulrushes (Cyperaceae: *Scirpus*). *Bartonia* **41**: 57–60.
- Smith S. G. and Yatskievych G. 1996. Notes on the genus *Scirpus* sensu lato in Missouri. *Rhodora* **98**: 168–179.
- Strong M. T. 1994. Taxonomy of *Scirpus*, *Trichophorum*, and *Schoenoplectus* (Cyperaceae) in Virginia. *Bartonia* **58**: 29–68.
- Tang T. and Wang F.-T. 1961. *Scirpus*. In: Chien S.-S. and Chun W.-Y. (eds.), *Flora Reipublicae Popularis Sinicae* **11**: 2–34. Science Press, Beijing.
- van der Veken P. 1965. Contribution a l'embryographie systematique des Cyperaceae–Cyperoideae. *Bull. Jard. Bot. Etat Bruxelles* **35**: 285–354.
- Wen J. 1999. Evolution of eastern Asian and eastern North American disjunct distributions in flowering plants. *Ann. Rev. Ecol. Syst.* **30**: 421–455.
- Wilson K. L. 1981. A synopsis of the genus *Scirpus* sens. lat. (Cyperaceae) in Australia. *Telopea* **2**: 153–172.
- . 1989. (1931) Proposal to conserve 468 *Scirpus* L. (Cyperaceae) with *S. sylvaticus* L. as type. *Taxon* **38**: 316–320.

Appendix I. Key to the Sections of *Schoenoplectus*

1. Achenes rugulose, blackish when ripe; floral scale apices entire; plants densely tufted, rhizomes very short, or in *Sch. lineolatus* spreading by long rhizomes2
1. Achenes smooth, yellow- to dark brown when ripe; floral scale apices clearly emarginate to bifid, or entire or nearly so in sect. *Malacogeton*; plants

- widely spreading by means of rhizomes3
2. One (rarely 2) node and leaf usually present on culm above basal leaf sheaths; plants often with flowers in basal leaf sheaths; perianth bristles absent from spikelet flowers, sometimes present in basal flowerssect. Supini
 2. All nodes crowded at base of culm; plants never forming flowers in basal leaf sheaths; perianth bristles present or absentsect. Actaeogeton
 3. Floral scale flanks each with 2 to ca. 10 prominent veins, at least in proximal part of spikelet, apices entire or obscurely emarginate; rhizomes weak, soft when mature, tubers often terminating rhizomes; often submerged aquatic; North America and East Asiasect. Malacogeton
 3. Floral scale flanks without veins (except often on basal scales), apices clearly emarginate to deeply bifid; rhizomes strong, hard when mature, tubers absent; emergent aquatic or on wet soils (*Sch. lacustris* sometimes submerged aquatic); world-wide sect. Schoenoplectus

Appendix II. List of Sections and Included Species from North America and East Asia

Schoenoplectus sect. *Schoenoplectus*

Sch. acutus (Muhl. ex Bigelow) A.Löve & D.Löve; *Sch. americanus* (Pers.) Volkart; *Sch. californicus* (C.A.Mey) Soják; *Sch. deltarum* (Schuyler) Soják; *Sch. heterochaetus* (Chase) Soják; *Sch. lacustris* (L.) Palla [type species]; *Sch. litoralis* (Schrud.) Palla; *Sch. pungens* (Vahl) Palla; *Sch. tabernaemontani* (C.C. Gmel.) Palla; *Sch. triqueter* (L.) Palla

Schoenoplectus sect. *Malacogeton* (Ohwi) S.G.Smith & Hayasaka

Sch. etuberculatus (Steud.) Soják; *Sch. nipponicus* (Makino) Soják [type species]; *Sch. subterminalis*

(Torr.) Soják; *Sch. torreyi* (Olney) Palla

It is possible that *Sch. ehrenbergii* (Böck.) Soják (see fig. 7 in Tang and Wang 1961) of China and S. E. Russia might be included in sect. *Malacogeton*, but we exclude it here pending further information.

Schoenoplectus sect. *Actaeogeton* (Rchb.) J.Raynal

Sch. fuscorubens (T.Koyama) T.Koyama; *Sch. hondoensis* (Ohwi) Soják; *Sch. hotarui* (Ohwi) Holub; *Sch. juncoides* (Roxb.) Palla; *Sch. komarovii* (Roshev.) Soják; *Sch. lineolatus* (Franch. & Sav.) T.Koyama; *Sch. mucronatus* (L.) Palla [type species]; *Sch. ohwianus* (T.Koyama) Holub; *Sch. orthorhizomatus* (Arai & Miyam.) Hayasaka & H.Ohashi; *Sch. purshianus* (Fern.) M.T.Strong; *Sch. smithii* (A.Gray) Soják; *Sch. subbisetosus* (T.Koyama) Soják; *Sch. triangulatus* (Roxb.) Soják; *Sch. wallichii* (Nees) T.Koyama

Schoenoplectus sect. *Supini* (Cherm.) J.Raynal

Sch. articulatus (L.) Palla; *Sch. erectus* (Poir.) Palla ex J.Raynal; *Sch. hallii* (A.Gray) S.G.Smith; *Sch. saximontanus* (Fern.) J.Raynal; *Sch. supinus* (L.) Palla [type species]

The infrageneric classification of *Schoenoplectus* given herein is based mainly on East Asian and North American species. A more complete infrageneric system based on world-wide species is needed. It is possible that more than four sections might be recognized within the genus, because some African species, e. g., *Sch. muriculatus* (Kük.) J.Browning and *Sch. paludicola* (Kunth) Palla ex J.Raynal cannot definitely be assigned to either of the four sections. Infraclassical taxa might also be recognized after a more detailed study of species, especially in sect. *Schoenoplectus*.

スミス S. G.^a, 早坂英介^b: フトイ属シズイ節 (カヤツリグサ科) の学名の新組み合わせ, 節の定義と種の区別

フトイ属シズイ節の学名の新組み合わせ
Schoenoplectus (Rchb.) Palla sect. *Malacogeton* (Ohwi) S.G.Smith & Hayasaka を提唱し, 節の形態的な特徴を記載した. シズイ節には北米に 3 種 *Sch. etuberculatus* (Steud.) Soják, *Sch. subterminalis* (Torr.) Soják, *Sch. torreyi* (Olney) Palla, および東アジアに 1 種 *Sch. nipponicus* (Makino) Soják シズイがある. これらの種への検索表を示し, 種の区別

点を明らかにした. また, フトイ属に 4 節 sect. *Schoenoplectus* フトイ節, sect. *Malacogeton* シズイ節, sect. *Actaeogeton* (Rchb.) J.Raynal カンガレイ節, sect. *Supini* (Cherm.) J. Raynal ホソガタホタルイ節を認めてこれらの節への検索表を示し, それぞれの節に含まれる北米と東アジアの種を一覧した.

^a ウィスコンシン大学生物学部,

^b 東北大学大学院理学研究科付属植物園